CLAIMS

What is claimed is:

1. An apparatus for calculating and displaying 3D seismic classification features comprising:

designation means for designating a path in a 3D volume;

reference means for selecting a reference starting and ending position;

a geo-operator calculated from the voxel data of said 3D volume, said geo-operator capable of having variable crossline, inline and vertical extent and having

an orientation direction such that it can be maintained tangent to said path, as it traverses from the start point to the endpoint of said path;

association means for associating horizontal (2D), vertical (2D) and arbitrary (3D) feature vectors with the geo-operator output; and

determination means for determining where the geo-operator has sufficient data for the calculation to form a valid output;

wherein the output of the geo-operator indicates a measure to which alternative prototypical feature tensors may be present along the path.

2. A process for a device for calculating and displaying 3D seismic classification features relying on a means of designating a path in a 3D volume comprising:

employing a geo-operator calculated from the voxel data of said 3D volume, said geo-operator capable of having variable crossline, inline and vertical extent and having a an

orientation direction such that it can be maintained tangent to said path, as it traverses from the start point to the endpoint of said path;

using an association means of associating horizontal (2D), vertical (2D) and arbitrary (3D) feature vectors with the output of said geo-operator; and

with a determination means of determining where the geo-operator has sufficient data for the calculation to form a valid output;

wherein the output of the geo-operator indicates a measure to which alternative prototypical feature tensors may be present along the path.

3. An apparatus for calculating and displaying 3D seismic classification features comprising:

a path in a 3D volume, the path having a reference start position and a reference end position; and

a geo-operator capable of generating an output, the geo-operator comprising:

an evaluation component that determines where the geo-operator has sufficient data to generate the output;

wherein the output of the geo-operator indicates a measure to which alternative prototypical feature tensors may be present along the path.

4. The apparatus of claim 3, wherein the feature vector is horizontal.

5. The apparatus of claim 3, wherein the feature vector is vertical.

6. The apparatus of claim 3, wherein the feature vector is arbitrary.

7. The apparatus of claim 3, wherein the feature vector is two dimensional.

8. The apparatus of claim 3, wherein the feature vector is three dimensional.

9. The apparatus of claim 3, wherein the geo-operator is calculated from voxel data of the 3D volume.

10. The apparatus of claim 3, wherein the geo-operator has a variable crossline.

11. The apparatus of claim 3, wherein the geo-operator has a variable inline.

12. The apparatus of claim 3, wherein the geo-operator has a vertical extent.

13. The apparatus of claim 3, wherein the geo-operator further comprises:

an orientation direction constructed and arranged to be maintained tangent to the path from the start position to the end position.

14. The apparatus of claim 3, wherein the geo-operator further comprises:

one or more feature vectors that are associated with the output of the geo-operator.

15. A method for calculating and displaying 3D seismic classification features along a path having a startpoint and an endpoint, comprising:

employing a geo-operator that is calculated from voxel data of the 3D volume, the geo-operator capable of having variable crossline, inline and vertical extent and having an orientation direction that is maintained tangent to the path as the path is traversed from the startpoint to the endpoint, the geo-operator generating output along the path;

determining where the geo-operator has sufficient data to generate the output;

generating output with the geo-operator; and

associating horizontal, vertical and arbitrary feature vectors with the output of the geo-operator;

wherein the output of the geo-operator indicates a measure to which alternative prototypical feature tensors may be present along the path.

16. An apparatus for locating an underground structure comprising:

a source of sensor information;

3D data covering at least a portion of the structure;

a geo-operator on a path within the 3D data, the geo-operator constructed and arranged to conform to the direction and the orientation of a tangent to the path, the geo-operator

further constructed and arranged to alter dynamically the size of the geo-operator depending on the conditions of a point along the path.

17. The method of claim 16, wherein the geo-operator further constructed and arranged to correlate with physical phenomena in order to describe a natural resource.

18. The method of claim 16, wherein the geo-operator further constructed and arranged to correlate with physical phenomena in order to align with a boundary for a natural resource.

19. The method of claim 16, wherein the geo-operator further constructed and arranged to correlate with physical phenomena in order to provide a mathematically discernible boundary for a natural resource.

20. The method of claim 16 wherein the sensor provides information of the group consisting of electromagnetic, gravity and particulate.

21. The method of claim 16, wherein the sensor information is seismic.

22. The method of claim 20, wherein the sensor provides information of the group consisting of electromagnetic, gravity and particulate.

23. The method of claim 16 further comprising:

drilling a well capable of recovering at least a portion of the natural resource.

24. A method of generating a map displaying a set of geologic characteristics specific to a path having a plurality of points, comprising:

assigning a calculation result based on the combined horizontal and vertical features centered at each point along the path;

assigning a visual indication of the result to each point of the path; and

assigning a validity measure to each of the points based on the availability of data in order to makes changes in the result discernible by an interpreter.

25. A method of developing a cardinality transformation comprising:

designating a path in a 3D volume;

determining, with a fitness function, the status of a selected reference classification feature in a form at an adjacent path position;

determining the translation movement of the position of a centroid of the classification feature in the transition to the adjacent path position;

determining the morphing scaling of one or more extents of the feature in the transition to the adjacent path position; and

recording the translation movement and the morphing scalings to form a catalog of the changes in the strata manifold.

26. The method of claim 25, wherein the selected reference classification feature is one dimensional.

27. The method of claim 25, wherein the selected reference classification feature is two dimensional.

28. The method of claim 25, wherein the selected reference classification feature is three dimensional.

29. The method of claim 25, wherein the status is present.

30. The method of claim 25, wherein the status is absent.

31. The method of claim 25, wherein after the step of designating, then selecting a starting position and an ending position along the path.

32. The method of claim 25, wherein the form is morphed.

33. The method of claim 25, wherein the form is unmorphed.

34. A method of data fusion comprising:

providing a path having a plurality of points;

performing a first calculation with a geo-operator using a first type of data in a calculation algorithm;

performing a second calculation using a second type of data to form an output of the geo-operator; and

switching the order of the first calculation and the second calculation at each point along the path;

wherein the output of the geo-operator provides an indication of both sensor data for determining the classification nature of each point on the path.

35. A method of data fusion comprising:

providing a path having a plurality of points;

performing a first calculation with a geo-operator using a first type of data in a calculation algorithm;

performing a second calculation using a second type of data to form an output of the geo-operator; and

admixing the first calculation and the second calculation at each point along the path;

wherein the output of the geo-operator provides an indication of both sensor data for determining the classification nature of each point on the path.

36. The method of 35, wherein the admixing is linear.

37. The method of claim 35, wherein the admixing is nonlinear.

38. The method of 35, wherein the admixing is mathematical.

39. A method of data fusion comprising:

providing a path having a plurality of points;

performing a first calculation with a geo-operator using a first type of data in a calculation algorithm;

performing a second calculation using a second type of data to form an output of the geo-operator; and

blending the first calculation and the second calculation at each point along the path;

wherein the output of the geo-operator provides an indication of both sensor data for determining the classification nature of each point on the path.

40. The method of 39, wherein the blending is visual.

41. The method of 39, wherein the blending is optical.

42. A program storage device including a plurality of instructions, the instructions adapted to be executed by a processor of a computer, the instructions, when executed by the processor, conducting a process which generates a map that displays a set of geologic

characteristics corresponding to the combined horizontal and vertical features based on data at one or more points along a path comprising:

assigning a calculation based on the combined horizontal and vertical features centered at each point along the path to form a result for that point;

assigning a visual indication of the calculation result for each point along the path; and

assigning a validity measure to each point along the path, the validity measure being based upon the availability of data for the calculation so that changes in the results are discernible by an interpreter.

43. A computer program product for generating a map that displays a set of geologic characteristics corresponding to the combined horizontal and vertical features based on data at one or more points along a path, the computer program product comprising:

A computer usable medium having a computer readable program code embodied in the medium for performing a calculation using as input the combined horizontal and vertical features centered at each point along the path, the computer readable program code including:

a first computer readable program code adapted for causing the computer to assign a computed result to each point along the path;

a second computer readable program code assigned to calculate a validity mask for the calculation along the path; and

a third computer readable program code assigned to provide the visualization of the path, the computed result and the validity mask.

44. An apparatus for mining underground structures comprising:

one or more sources;

one or more receivers;

a tool to mine in a designated place;

a feedback system relying on the data obtained from the sources and the receivers to maintain the tool in the designated place most productively, the feedback system controlling the tool to recover a portion of a natural resource using information from a geo-operator.

45. The method of claim 44, further comprising:

controlling the sources and receivers in real-time to modify the characteristics of the processing of the sources or receivers based upon the geo-operator to improve the quality of the natural resource.

46. The method of claim 44, wherein the source is seismic.

47. The method of claim 44, wherein the source is electromagnetic.

48. The method of claim 44, wherein the source is electric.

49. The method of claim 44, wherein the source is magnetic.

50. The method of claim 44, wherein the source is gravity.

51. The method of claim 44, wherein the source is particulate.

52. The method of claim 44, wherein the receiver is seismic.

53. The method of claim 44, wherein the receiver is electromagnetic.

54. The method of claim 44, wherein the receiver is electric.

55. The method of claim 44, wherein the receiver is magnetic.

56. The method of claim 44, wherein the receiver is gravity.

57. The method of claim 44, wherein the receiver is particulate.

58. The method of claim 44, wherein the tool is a cutting tool.

59. The method of claim 44, wherein the tool is an excavation tool.

60. The method of claim 44, wherein the tool is a drilling tool.

61. The method of claim 44, wherein the designated place is a channel.

62. The method of claim 44, wherein the designated place is a bed.

63. The method of claim 44, wherein the information from the geo-operator is based upon the results of a geo-operator calculation.

64. The method of claim 44, wherein the information of the geo-operator is control information.

65. The method of claim 44, wherein the information of the geo-operator is regulator information.

66. The method of claim 45, wherein the characteristic is directionality.

67. The method of claim 45, wherein the characteristic is waveform.